

WHAT IS CLAIMED IS:

1. A nitride semiconductor substrate having a diameter of 10 mm or more, which has a single-layer structure composed of a nitride semiconductor layer having a basic composition represented by $\text{Al}_x\text{Ga}_{1-x}\text{N}$ (0 ≤ x ≤ 1), or a multi-layer structure comprising said nitride semiconductor layer, the mass density of said nitride semiconductor layer being 98% or more of a theoretical mass density $\rho(x)$ represented by the following general formula (1):

$$\rho(x) = \frac{4(M_x + M_N)}{\sqrt{3}a_x^2 c_x N_a} \cdot \cdot \cdot (1),$$

10 wherein $a_x = a_{\text{GaN}} + (a_{\text{AlN}} - a_{\text{GaN}})x$, wherein a_{GaN} represents an a-axis length of GaN, and a_{AlN} represents an a-axis length of AlN; $c_x = c_{\text{GaN}} + (c_{\text{AlN}} - c_{\text{GaN}})x$, wherein c_{GaN} represents a c-axis length of GaN, and c_{AlN} represents a c-axis length of AlN; $M_x = M_{\text{Ga}} + (M_{\text{Al}} - M_{\text{Ga}})x$, wherein M_{Ga} represents the atomic weight of Ga, and M_{Al} represents the atomic weight of Al; M_N represents the atomic weight of nitrogen; and N_a represents Avogadro's number.

2. The nitride semiconductor substrate according to claim 1, wherein it is a self-supported substrate composed of said nitride semiconductor layer.

20 3. The nitride semiconductor substrate according to claim 2, wherein said nitride semiconductor layer has a thickness of 200 μm or more.

4. The nitride semiconductor substrate according to claim 1, wherein a distribution of said mass density is within ± 0.1% in a plane.

25 5. The nitride semiconductor substrate according to claim 1, wherein a distribution of said mass density is within ± 0.2% in a thickness direction.

6. The nitride semiconductor substrate according to claim 1, wherein said nitride semiconductor layer is composed of a single crystal.

7. The nitride semiconductor substrate according to claim 1, wherein said nitride semiconductor layer has a threading edge dislocation density of $1 \times 10^7 \text{ cm}^{-2}$ or less.
8. A method for producing the nitride semiconductor substrate
5 according to claim 1, wherein said nitride semiconductor layer is grown by a hydride vapor-phase epitaxy method.
9. The method for producing a nitride semiconductor substrate according to claim 8, wherein a nitrogen compound gas used as a starting material for said nitride semiconductor layer has a partial pressure of 50
10 kPa or more.
10. The method for producing a nitride semiconductor substrate according to claim 8, wherein said nitride semiconductor layer is epitaxially grown on a different substrate.
11. The method for producing a nitride semiconductor substrate
15 according to claim 10, wherein the epitaxially grown nitride semiconductor layer is separated from the different substrate to provide a self-supported substrate of a nitride semiconductor.
12. The method for producing a nitride semiconductor substrate according to claim 8, wherein after said nitride semiconductor layer is
20 epitaxially grown, a heat treatment is conducted in an atmosphere containing a nitrogen compound gas.
13. The method for producing a nitride semiconductor substrate according to claim 12, wherein said heat treatment is conducted at a pressure of 4 MPa or more.
- 25 14. The method for producing a nitride semiconductor substrate according to claim 12, wherein a heat treatment temperature is 400-1200°C.